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# SIMON: asSIsted Mobility for Older aNd impaired users

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**Abstract**

SIMON is a demonstration project with three large scale pilots in Madrid, Lisbon and Parma aiming to use ICT services to promote the independent living and societal participation of mobility impaired people in the context of on-street public parking areas and multiple transport modes.
The project tackles two main challenges:
- Reduction of fraud by demonstrating the use of an **ICT – enhanced European Disable Badge for public parking**, both on the basis of physical – i.e. smartcards – and virtual access right tokens – i.e. e-access through mobile devices.
- Proposal of **specific multimodal navigation solutions** for elderly and disabled people, using opendata hubs and preexisting toolsets that will be populated and exploited with specific information – e.g. elevators located near sub-way stations.
An additional challenge is the instantiation of a proven methodology for data privacy preservation and authentication of users.
SIMON builds on existing mobility services, using the current infrastructure of the cities, and adds the required integration work to provide a seamless services integration layer which can be instantiated in different cities according to the specific context and the services available. Thus, from an ICT point of view, SIMON services are adaptable to heterogeneous environment, with different capabilities.
The SIMON system platform supports some services that feed different applications, all of them accessible through different mobile devices. A backoffice also provides the access through a web application to let the public authority manage the whole system.

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## 1. Introduction

SIMON is an EC funded demonstration project (CIP-ICT-PSP-2013-7-621041) with three large-scale pilots in Madrid, Lisbon and Parma aiming to use ICT services to promote the independent living and societal participation of mobility-impaired people in the context of on-street public parking areas and multiple transport modes.

The project tackles two main challenges: reduction of fraud in the pre-ICT implementation of the European Disable Badge for public parking areas, and the proposal of specific multimodal navigation solutions for elderly and people with disabilities.

Both cases require extensive integration of multiple databases with dedicated personal information. Thus, an additional challenge the project has to assume is the instantiation of a proven methodology for data privacy preservation and authentication of users.

This paper describes the overall system proposed to provide enhanced ICT services to the cities, which already count with a pre-existing infrastructure to support mobility impaired users. The process followed to ensure that technology is correctly addressing the needs of mobility impaired users will be described while services and applications delivered by the project will be depicted, focusing in the services to ensure the management of access rights for on-street parking and restricted urban areas. The idea of a wider European deployment which considers both transferability and scalability of the system will be shown as a logical outcome of this project.

## 2. SIMON project: a solution for mobility impaired people

### *2.1. The challenge*

Accessibility is a broad concept that addresses the removal and prevention of barriers that cause problems for persons with disabilities when using products, services and public infrastructure. Successful actions can enable those persons with disabilities to live more equally alongside those without disabilities.

The accessibility challenges facing society today are most visible in urban areas. The solutions for improving accessibility are most in evidence in those forward-thinking cities that are demonstrating commitment and innovation in changing the urban environment to allow all people to fully enjoy city life.

People with reduced mobility is often described as a single homogeneous group, however it is a heterogeneous group of people that differ in age and life styles, physical and mental characteristics, or travel patterns and transport needs.

Thus, even if the accessibility barrier may be the same, the response to overcome such barrier should attend the specifics needs of each end-user. There is a need to first identify the requirements of each targeted type of citizen with reduced mobility in order to improve their mobility capabilities.

The challenges identified in order to contribute to an enhancement on the urban mobility of the elderly and the disabled people are the following:

- New mobility schemas must support the access of elderly and disable people to the same opportunities as the rest of citizens.
- Mobile applications and a web platform can be used as an open communication channel with citizens, including specific navigation features supporting mobility disable people.
- Authorities must be provided with the capability to promote inclusion policies whilst fighting against fraud – e.g. univocal identification of user and disable parking badge.
- Specific IT solutions for specific targeted end-users should be proposed, always with a focus on usability and user-friendliness, with the ultimate goal is to achieve an enhanced experience for the user.

The ultimate motivation of SIMON is its planned result: promoting the independent living and societal participation of mobility impaired people supporting them in the access to public and private transport modes.

Large scale pilots in Madrid, Lisbon and Parma have to definitely push forward the already substantial work on accessibility that these three sites have conducted, consolidating their pioneering positions at the forefront of EU and international fair mobility policies addressing impaired users' needs.

### *2.2. Contribution to European policies*

In many European countries there are national policies and initiatives aimed to improve the accessibility to goods and services and to ensure that people with disabilities enjoy all benefits of EU citizenship; for example the UK, Italy, Spain and Portugal all have state policies on removing barriers to equal access to transport and mobility infrastructures amongst impaired people. However, there are also many countries where social inclusion of mobility impaired people is not high up the policy agenda, where there are perhaps more pressing or at least politically obvious problems related to the general population to be solved, or where old age or disability loses out to the needs of the young and more politically visible. Even in the countries where there are well developed national initiatives for inclusive mobility there can be a considerable gap between aspirations and delivery of services and outcomes. There are still many obstacles preventing people with disabilities from fully exercising their fundamental rights – including their Union citizenship rights – and limiting their participation in society on an equal basis with others.

As a result, people with disabilities are poorer than other citizens of the EU, fewer of them have jobs, their opportunities to enjoy goods and services such as education, healthcare, transport, housing, and technology are more limited. This problem is due to the still existing discrimination as well as physical and attitudinal barriers and affects one in six citizens of the EU, around 80 million people (European Commission, 2004).

With the support of ICT solutions, SIMON specifically contributes to improve the access to public disabled parking spaces and certain restricted areas of a city, and support their travelling experience by providing them with specific information about spaces and places accessible to people with reduced mobility (Ferreras et al. 2015).

Targeting several of the European key challenges, the accomplishment of SIMON will lead to a number of benefits contributing to the policies, targets and guidelines established by the European Union as well as to National policies of the participating Member States, while creating synergies with the different proposed initiatives and policies. In particular, SIMON objectives are aligned with the following European policies: European Disability Strategy 2010–2020 (European Commission, 2010a) and Europe 2020 strategy (European Commission, 2010b).

### *2.3. The European Disabled Badge*

The EU standardised model of parking card for the disabled allows a disabled person who is entitled to use certain parking facilities in his EU country of residence to move more easily in the territory of another EU country and avail themselves of all the parking facilities granted to the card-holders in that EU country.

A Council Recommendation from 1998 (Official Journal of the European Community, 1998) updated in 2008 (Official Journal of the European Community, 2008) presented a standardized proposal for the layout of parking cards for people with disabilities and their recognition by the EU countries, in order to facilitate such people's freedom of movement by car. The Annex entitled "Provisions on the Community-model parking card for people with disabilities" contains very specific provisions on what the standard European card should look like, specifies its height, width, colour, material (plastic-coated), content and how and where the information specific to the EU countries is to be displayed.

The misuse of these permits is a growing problem worldwide. It is especially acute in large cities, where parking is expensive and availability is limited. Drivers with disabilities that are allowed to hold a disabled badge can face different problems trying to find accessible parking spaces, because many of those spots are taken by able-bodied people who are doing a fraudulent use of the badge, most of the times by using a duplicate (which is absolutely forbidden) and some others by directly using the original one without carrying the disabled authorized user in the car.

Thus, there is a need to explore different ICT-based solutions to enhance the European disabled badge in order to ensure the correct use but also keeping the original nature of the badge aiming at the free movement and independent living of disabled EU citizens.

### *2.4. The state-of-the-art on existing apps for mobility impaired people*

In recent years a lot of applications have been developed based on GPS positioning capabilities based on GPS and taking into account the users with reduced mobility, including disabled and elderly. Most of these solutions and devices are simply adaptations of standard systems that include accessibility features to make them usable by different functional profiles (mainly visual impaired people).

Dedicated accessibility and mobility apps are available, but they present some restrictions and limitations. The main issue is the limited scope within the disability range: Specific navigation apps are mostly designed for visual impaired or blind (*GetThere*, *NowNav GPS Accessibility* and more, available at the Google Play Store (Google (2015)). These applications mainly integrate a very simple interface with the basic functionalities and substitute the visual map with spoken instructions.

Navigation apps for physical impaired are starting to gain importance. Examples like *NavChair* have tried to create a "wheelchair mode" for GPSS-based navigation systems, where the routes can be provided either by the system's users (e.g. Web 2.0) or by businesses, institutions and interested parties. EasyWheel (Menkens et al. (2011)) has designed and implemented a mobile wheelchair navigation and support system. Some other works as Umezu et al. (2013) have been carried out to find routes for elderly people, presenting a barrier notification service running on the user smartphone.

Besides the adapted routes and instructions, other important need is the location of specific accessibility landmarks (parking spots, accessible services, transport, etc.). Some apps offer these functionalities: *Accesibility Plus*, *It's Accessible*, *Mob Ramp*, *WheelMate*, *Wheelmap*, *On Wheels*, etc (all of them available at Google (2015)). Although these are interesting initiatives, they do not integrate the big data of municipalities, using only private material that can become easily out of date; furthermore, most of them use information provided by the users themselves, acting like social networks in accessibility. This option based on the crowd-sourcing is very interesting, always that the reliability and validity of the information is contrasted or updated and the continuous participation of a big number of users is granted.

Another issue is the lack of integration between different modes of transport. Some of the existing and most commonly used applications, like *TripGo*, *Google Maps* or Transit App try to fill this gap, but mainly allowing the selection of the preferred mode (public transport, private car, walking), not with real multimodality. Furthermore they do not consider accessibility or the needs of mobility impaired users. Exceptions to this situation are developments such as *Assistant* (Siira and Heinonen (2015)) that aims at combining the accessible design with the creation of multimodal routes adapted to different profiles of elderly users. The limitation of this system is that routes must be created in advance with an external application.

Finally, there are different apps that have been created to help disabled users to find reserved parking spaces (*Disabled Park*, *Parkible*, *Park-abled* and many others). Similarly as in the navigation apps, most of these applications are based on social networks or rely on the identification of the spots by the users and they are usually only focusing a unique city. They can be useful to, for example, denounce fraud (as in *Parking Mobility*) but it is not reliable system to find or manage parking spaces. As a remark, they do not include any mechanism to validate or manage the right access to the parking spaces. Nevertheless, new solutions are currently being developed based on the sensor-based monitoring of reserved parking lots (Lambrinos and Dosis (2013)). While these proposals have undeniable technological advantages to detect a correct use of the reserved parking places for the disabled, they leave out the regulation and the standardized proposal of a common European parking card for the disabled, posing serious inconveniences for a transferable, interoperable and scalable solution that grants the free movement of the disabled around different cities.

As a conclusion, none of the solutions combine the different functionalities required to ensure an integrated and complete mobility in ac unique application: multimodal navigation (including data on accessibility and accessible transport through the big-data of cities), location and navigation to reserved parking spaces, access to restricted

areas, adapted interface, etc. Especially, there is no application that can integrate these aspects with the use of a parking card for people with disabilities to validate parking and prevent fraud.

## 3. SIMON platform

### *3.1. An overview*

SIMON final objective is the promotion of the independent living and societal participation of mobility impaired people through the adoption of technology to provide the users specific navigation information and access-rights management solutions.

SIMON proposes a mobile application to support impaired citizens in the use of public and private transport modes. This application makes use of specific information and navigation functionalities, and provides e-id mechanisms to reduce fraud. In this same context, SIMON enhances the European parking card for disabled people with contactless technologies and integrates mobile solutions to support user unique identification in existing park meters whilst preserving privacy.

Usability, accessibility and ergonomics are key factors to be considered, in order to ensure that all populations are able to access and use a physical or logical system. This is especially important when the system addressees are persons with disabilities. It is therefore necessary to develop requirements that consider all these aspects.

Functional requirements are another fundamental or essential subject matter of the system. They describe what the product has to do or what processing actions it is to take. The functional requirements are highly connected with the usability, performance, look or security aspects (classified as “non-functional requirements”) and also with the use cases that are used mainly to describe system actions when interacting with the actor.

The whole set of requirements developed at the first phase of the project was applied during the next stages to guide in the definition of the reference architecture, the information model, the ICT services and the different applications (access-right management and navigation information).

### *3.2. Scenarios and use cases*

In the context of architecture and design, a use case is basically a description of a set of interactions between the system and one or more actors (either a user or another system). A scenario is a broader and more encompassing description of a user's interaction with the system, rather than a path through a use case. Several key scenarios were identified that have helped to make decisions about the architecture.

SIMON services have been deployed in three specific pilot sites – Madrid, Lisbon and Parma – with existing initiatives running and special features that complement each other to provide a global solution. Whilst the services identified by SIMON are common to the architecture, and therefore to each of the test sites, the services already deployed in each pilot covering the basic functionalities for parking management and control and navigation information have different implementations. The available ICT services in place have been identified to later adapt them and instantiate SIMON trying to follow a common approach.

The generic architecture of the system has been validated against the use cases defined in the first project phase (Ferreras et al. (2015)), which has been also useful to further refine the initially defined set of use cases, to determine with a high level of accuracy which of them shall be implemented in SIMON and which of them are candidates to be less prioritized and probably not implemented since their low usefulness has been proved.

A list of generic scenarios has been identified through the analysis of the use cases list:

- Scenario 1: Learning. It encompasses several use cases involving different actors that have to learn how to use the system. It has not a serious impact on the architecture but on the user application design, since a number of help buttons might be needed in the app, and help /tutorials will be available at the website.
- Scenario 2: using the public transport. The citizen will be able to use the public transport, on one hand he will use the app to plan a trip and furthermore he will receive information about accessible public transport in real time.
- Scenario 3: using the private vehicle to move and park on the city. The citizen will use his own vehicle to get around the city and he will be able to plan the trip, to search for parking spaces and he will be guided to them.

- Scenario 4: citizen identification at a parking place. The citizen will validate his identity in the system when he parks so he will be identified as a valid blue badge holder. Different mechanisms will be available for this, depending on the device the user is able to use (smart phone, mobile, none). In line with this, the citizen shall be able also to notify when he is leaving the parking space.
- Scenario 5: booking a parking space. This scenario is considered for private parking spaces, where the user could be able to check the status (occupied, free) of the places and to book one of them.
- Scenario 6: citizen identification at a restricted urban area. The citizen will validate his id in the system when he accesses to a restricted urban area so he will be identified as a valid user.
- Scenario 7: controller checking the validity of the parking or the badge. The enforcement officer will be able to check if a car is correctly parked, to verify the validity of a user's badge, and to notify when a misuse is detected. This scenario foresees all the tasks allocated to a controller in the system.
- Scenario 8: authority and operator management. The public authority or the transport operator in charge of managing the system will use different functionalities through the system backoffice.

### *3.3. The process of creation*

The initial design of services and applications was done according to the well-defined reference architecture. This reference architecture facilitates the deployment and adoption by citizens, mobility service providers, parking managers, public authorities, public transport operators and mobility managers. The specific needs and constraints to get optimal integration, deployment and service operations have been considered, analysing the needs of each stakeholder, the different use cases available and the integration with traditional public transport systems and existing parking management solutions. SIMON adopts an implementation approach which ensures the integration of access rights management to public parking spaces or restricted urban areas with the technology available in each site, as well as the availability of multimodal travel information coming from public transport operators' data. Furthermore, it ensures transferability across Europe, not imposing constraints to the already existing policies.

Once the first version of services was ready, the following steps were the integration of services and applications and the adaptation to each of the pilot cities started. During these activities, new needs and issues were identified, and consequently several modifications were done to improve the design of the app but also to include enhance features. Additionally, some of the needs were detected by the development team during the integration process: potential weaknesses, inconsistencies and vulnerabilities were identified, and a redesign of the corresponding features was performed.

Finally, a set of small scale pilot tests was designed and executed with a limited number of selected users at each of the three pilot sites. Tests were mainly oriented to detect usability issues, especially for users with disabilities. As a result of this process, new refinements were done in both services and applications, concluding with the first release of the SIMON system ready to be used in the large scale pilots.

### *3.4. SIMON services and applications*

SIMON system integrates four main services: SIMON SAYS provides the core identity management functions to enable the validation and verification of a blue badge holder when parking at a reserved parking space. SIMON BOOKS provides the functions to determine the availability of reserved parking spots. SIMON OPENS provides the functionality to establish access to urban restricted areas and SIMON ANSWERS provides the functions to enable multi-modal navigation. This set of services feed the SIMON mobile apps, which are used in the pilot phase: SIMON LEADS for the mobility impaired citizens and SIMON CONTROLS for the enforcement officers.

The SIMON LEADS mobile application integrates navigation services, validation services and information services related to mobility in a single application that is adapted to the needs of mobility-impaired persons. In order to achieve this targeted adaptation, the application design has been created and iterated using a focus group that encompassed mobility-impaired persons. Being the application targeted towards the mobility-impaired end-users, special care has been taken to make the application accessible to users with different impairments. As requested by the users of the focus group, the application does not contain tutorials but instead features a consistent contextual help screen that can be brought up at any point in time through the main menu.

SIMON services for guidance and routing are intended to be used mainly on-the-move and for that reason have been designed to run on users' mobile phones, which act as the hardware platform for the execution of the SIMON LEADS application. The citizens' mobile phones are also used as personal identification tokens that contribute to the verification of the personal identity and the validation of the access rights to the parking spots and the restricted areas. Mobile phones are also the devices that parking controllers use for running the SIMON CONTROLS application that shall allow them to confirm the validation of the usage of parking spaces.

The navigation functions of SIMON LEADS enable mobility-impaired persons to navigate through the target cities in a multi-modal manner that is adapted to their preferences and abilities, meaning that the routes computed for them consider their mobility preferences as well as their specific mobility restrictions (e.g. wheelchair accessible), etc. When accessing the navigation functions, the application enables the user to explore the environment, find locations, etc in a map. It also allows the user to determine the origin and destination of a route as well as to set the routing options such as the mode of transportation or the number of alternatives to compute. Finally, it also provides the ability to store and access favorite locations.

One of the main innovations of this system is the capacity of fighting fraud in the use of the European Disabled Badge. Towards this end, two elements have been physically incorporated to the disabled citizen's EU badge: a NFC tag in which a user identification code is electronically written and a sticker with a QR code printed on it, containing a user identification code. In both cases, the user's smart phone is expected to read the user identification from the EU badge. This shall be used both when the citizen validates his/her own usage of a parking spot or access to a restricted area, or when the parking controller checks the validity of the card behind the windscreen of a parked car.

The service SIMON SAYS provides the functionalities related to the authentication of users, validation of the user badges (NFC, QR code, user IDs) and parking permission control. SIMON OPENS provides the identification of users when they try to access a restricted urban area (controlled by barriers or cameras for plate recognition).

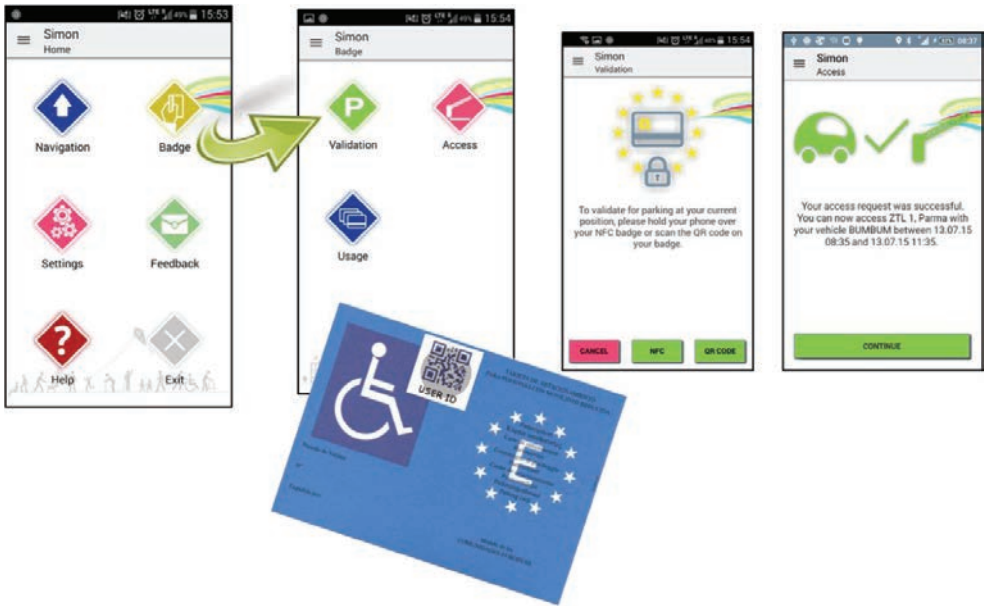


Fig. 1. SIMON Mobile app: validation of user's operations.

Both services interact with the SIMON BACKOFFICE provided to the public authorities in charge of managing the city infrastructures and of ensuring the correct application of the mobility policies. This backoffice is used for security, authentication and permissions, includes a "Parking resources and control management module" for checking availability of car park spaces and an "Usage and incidents logger" that allows the logging of the different

operations registered in the platform. Finally, it also interacts with Park meters adaptor for fraud control (challenge strategy for user validation, emission of tickets, etc.).

Phones to be used by citizens can be either regular phones or smart phones, providing the latest more convenient and reliable features. Specific characteristics of the smart phones make them a key element to enhance the user experience: the GPS receiver shall provide the position of the citizen by the time of validating the usage of a parking spot, or the access to a restricted area, in order to check that the user is actually near the spot or area. For those validation purposes, the phone camera may be used to read the QR code printed on EU badges in order to read the identification of the user; and finally, for those devices that support this technology, the NFC receiver shall be used, in order to read the identification of the tag attached to the citizen's EU badge and confirm the validity of the card. In the case of regular phones, they are used just as receivers of short messages (SMS) and only for the validation of parking in combination with park meters.

The main functionality of SIMON CONTROLS is to check whether a user has been validated in the system to make use of a specific parking space or not. In case that the user has not done the validation or has no right to park in that place, the enforcement officer can notify the infraction and act according the municipality law. This operation is very important for the parking service management in order to keep control of the parking area and also to offer the citizen the best quality of service.

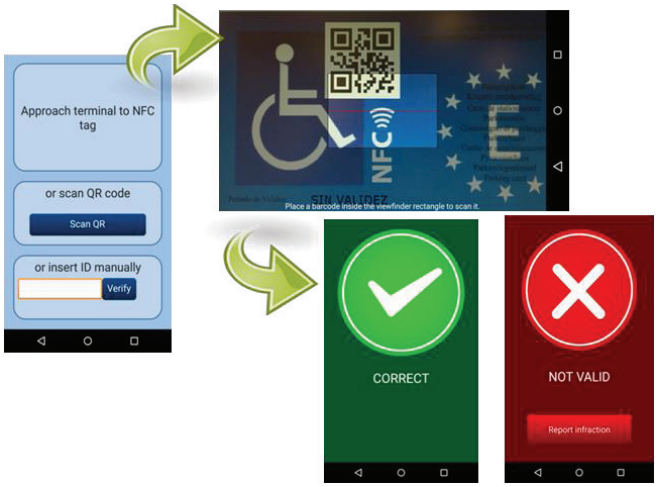


Fig. 2. SIMON CONTROLS app.

### *3.5. The small scale pilot*

A small scale testing was considered essential for a preliminary assessment and to detect if the ICT services deployed are robust. Furthermore, it is also a tool to use the first prototypes of the mobile applications – both for citizen and controllers – in order to validate usability and to obtain a first feedback from users about the fulfilment of SIMON requirements as defined in the initial phase of the project.

During the months of May, June and July 2015 the small scale pilot was carried out at each of the pilot sites with the collaboration of some selected users. A first prototype version of services and applications (SIMON LEADS for the disabled citizen, SIMON CONTROLS for the enforcement officers) was available to be tested. Specific procedures were followed in order to assess about the users becoming familiar with the app, learning or understanding the main functionalities and detecting improvable elements. Thus, the tests covered three different phases: (i) the user profiling, aimed at characterizing the participants (ii) the tasks development and individual inspection in which the user performed different activities, and (iii) the interview to analyze the application performance after completing all the tasks.

In general, both applications have been positively assessed (above 3.8 on a scale of 5 points) from utility and usability point of view (Fig. 3).

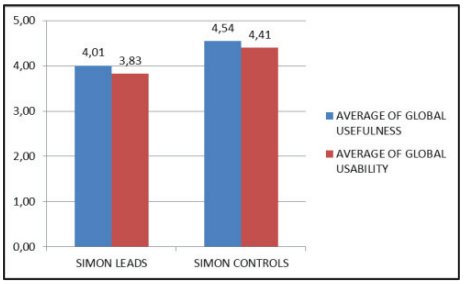


Fig. 3. Global assessment of SIMON LEADS and CONTROLS. Scale of 5 points (1: Totally disagree, 5: Totally agree).

On the one hand, the high scores of SIMON LEADS highlights its good design, taking into account that users had heterogeneous visual, physical, sensory and cognitive capabilities. Therefore, it was really difficult to achieve an accessible and usable design for all of them. On the other hand, SIMON CONTROLS prioritizes ease of use and simplicity to facilitate controller works. In fact, the results emphasize the idea that it facilitates the work of these professionals.

Usefulness of SIMON LEADS is positively assessed due to its wide and valuable set of functions. All usefulness criteria are assessed above 3 on a scale of 1 to 5. The best valued functions are: the overall usefulness of the system (4.69), the functionality of parking (4.50), and its potential to improve mobility in the city (4.31). However, improvements must be done on aesthetics and provided data. Usability is worse assessed than usefulness, but it should be taken into account the complexity to cover the accessibility and usability requirements for all profiles. All usability criteria are assessed above 3 on a scale of 1 to 5. The best assessed are the feeling of safety, comfort and the parking validation, while the worst assessed are presented data, time table of bus and learning. In general, the application has been positively assessed (4.01 for utility and 3.85 for usability). Although the main aspects have been well valued, some issues have been clearly detected by the users with regards to simply not intuitive tasks, which might require initial training or guidance.

Regarding SIMON CONTROLS, usefulness is assessed above in all criteria, being the best assessed: its daily use, validate vehicles and work improvement. Analogously to utility, the usability is also positively assessed, being all criteria assessed above 4 except the use of NFC for validation. In fact, few improvements have been detected, which are mainly related to the alternative for data introduction. Another issue is the readability of the disabled badge through the windscreen, but it is mainly related to hardware limitations.

This initial contact to learn about the users' experience was proven crucial to continue with the further fine--tuning of SIMON services and apps: the results of these tests and the evaluation of the conclusions determined how the ICT services have been be refined to start with the large scale pilot phase, which will be evaluated in 2016.

## 4. Conclusions

SIMON is providing specific IT solutions for specific targeted end users, to achieve an enhanced experience for them. This is possible thanks to the integration of existing services with the SIMON specific solutions for validation and multimodal navigation. Once the reference architecture and the information model have been defined, and the ICT services and applications are implemented, the last stage in the SIMON preparation phase finishes with the deployment and adaptation of these ICT services at each of the pilot cities. Thus, the services are instantiated to provide the functionalities required by each of the cities and while there are some of them that are common for all the pilot sites, some others are particular and have required specific integrations.

A Small Scale Piloting phase has proven to be very useful to test a first release of the SIMON applications and services, and to pave the way to the Large Scale Pilot phase. Although the initial work foreseen by the project only considered the definition of a set of tests to check the robustness of the ICT services deployed, the Consortium decide to go beyond this concept and also assess usability aspects and the mobile apps as a whole.

Pilots have been designed to form a scalable base for long term deployment: This will be achieved at two levels. On the one hand, SIMON pilots already consider accessibility as a long-term commitment with full political and institutional backing; on the other, the consortium will produce a Roadmap for deployment at European level, where milestones, barriers and actions to overcome them are identified in order to make SIMON a fully deployed reality within the next decade.

More information about the project activities can be found at http://simon-project.eu.

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